CLAIMS

What is claimed is:

1. An injector system comprising:

(a) an injection control unit for use in injecting a medicinal substance into a patient;

(b) a controller for controlling operation of said injector system inclusive of whether said injector system operates in an idle mode or a non-idle mode; and

(c) a battery charger system for providing power to said injection control unit, said battery charger system comprising:

(I) a power supply for converting AC power from a source thereof to DC power; and

(II) a battery pack including a battery and a charging module, said charging module for monitoring the mode of operation of said injector system such that when said battery pack is:

(A) disconnected from said injection control unit, said charging module enables said power supply to charge said battery with the DC power therefrom; and

(B) connected to said injection control unit, (i) upon detecting said injector system in said idle mode, said charger module routes the DC power from said power supply to both said battery for the charging thereof and said injection control unit for operation thereof; and (ii) upon detecting said injector system in said non-idle mode, said charger module prevents said power supply from charging said battery and enables said battery to provide DC power to said injection control unit.

2. The injector system of claim 1 wherein said charging module comprises:

(a) an output selector stage for sensing the mode of operation of said injection control unit and for providing a turn-on signal when said injection control unit is operating in said idle mode and a turn-off signal when said injection control unit is operating in said non-idle mode;

(b) a charging stage connected to said output selector stage such that upon receiving (I) said turn-off signal, said charging stage prevents said battery from being charged by said power supply and enables said battery to provide DC power to said injection control unit and (II) said turn-on signal, said charging stage enables DC power from said power supply to be conveyed to said injection control unit and assumes:

(A) a low current charging mode, when a voltage level of said battery is less than a preselected minimum level, wherein said charging stage charges said battery with a charging current therefor limited to a trickle level, and

(B) a multi-state charging mode, when said voltage level of said battery is said preselected minimum level or greater, wherein said charging stage operates according to:

(i) a bulk-charge state, when said voltage level of said battery is said preselected minimum level or greater yet below a set percentage of an overcharge level, wherein said charging stage charges said battery with said charging current at a peak level thereof,

(ii) an over-charge state, when said voltage level of said battery is equal to or exceeds said set percentage of said overcharge level, wherein said charging stage continues charging said battery until said charging current falls to a minimum threshold, and

(iii) a standby state, when said charging current falls below said minimum threshold, wherein said charging stage applies a constant voltage to said battery until said voltage level of said battery drops at least a specified percentage below a float level

upon which said charging stage will commence operating according to said bulk-charge state; and

(c) an indicator stage for indicating when said power supply is capable of providing to the charging module sufficient power to efficiently charge said battery.

3. The injector system of claim 1 wherein, when said power supply is disconnected from said battery pack, said charging module enables said battery to provide DC power to said injection control unit whether said injector system is operating in said non-idle mode or said idle mode.

4. A battery charger system for an injector system, said injector system having an idle mode of operation and a non-idle mode of operation, the battery charger system comprising:

(a) a first power cord for conveying AC power from a source thereof;

(b) an AC/DC converter for converting the AC power received from said first power cord to DC power;

(c) a second power cord for conveying the DC power received from an output of said AC/DC converter; and

(d) a battery pack including a battery and a charging module, said charging module for receiving the DC power from said AC/DC converter via said second power cord and for monitoring the operating mode of said injector system such that when said injector system is operating in (I) said idle mode, said charger module provides the DC power received from said AC/DC converter to said battery for the charging thereof and (II) said non-idle mode, said charger module prevents the

DC power from said AC/DC converter from reaching said battery and thus enables said battery to provide DC power to said injector system.

5. The battery charger system of claim 4 wherein said charger module also provides the DC power received from said AC/DC converter to said injector system when said injector system is operating is said idle mode of operation.

6. The battery charger system of claim 4 wherein said charger module also enables the DC power from said AC/DC converter to charge said battery when said battery pack is disconnected from said injector system.

7. The battery charger system of claim 4 wherein, when said AC/DC converter is disconnected from said battery pack, said charging module enables said battery to provide DC power to said injector system whether said injector system is operating in said non-idle mode or said idle mode.

8. The battery charger system of claim 4 wherein said second power cord comprises:

(a) a central section for routing into an aperture of a penetration panel;

(b) a first end section on a first side of the penetration panel for interconnecting said central section and said AC/DC converter; and

(c) a second end section on a second side of the penetration panel for interconnecting said central section and said battery pack.

9. The battery charger system of claim 8 wherein said central section comprises:

(a) a circular connector at one end thereof for connection to said first end section; and

(b) a D-shell connector at another end thereof routed into said aperture for connection to said second end section.

10. The battery charger system of claim 8 wherein said central section comprises:

(a) a D-shell connector at one end thereof for connection to said second end section; and

(b) a circular connector at another end thereof routed into said aperture for connection to said first end section.

11. The battery charger system of claim 8 further comprising ferrite clamps installed on both ends of said second end section.

12. A battery charger system for use with an injection control unit of an injector system, the battery charger system comprising:

(a) an AC/DC converter for converting AC power from a source thereof to DC power; and

(b) a battery pack including a battery and a charging module, said charging module for monitoring an operating mode of said injector system such that when said battery pack is:

(I) disconnected from said injection control unit, said charging module enables said AC/DC converter to charge said battery with the DC power therefrom; and

(II) connected to said injection control unit, (A) upon detecting said injector system in an idle mode of operation, said charger module routes the DC power from said AC/DC

converter to both said battery for the charging thereof and said injection control unit for operation thereof; and (B) upon detecting said injector system in a non-idle mode of operation, said charger module prevents said AC/DC converter from charging said battery and enables said battery to provide DC power to said injection control unit.

13. The battery charger system of claim 12 wherein, when said AC/DC converter is disconnected from said battery pack, said charging module enables said battery to provide DC power to said injection control unit whether said injector system is operating in said non-idle mode or said idle mode.

14. The battery charger system of claim 12 further including a DC power cord for interconnecting said AC/DC converter and said battery pack on opposites sides of a penetration panel, said DC power cord comprising:

(a) a central section for routing into an aperture of the penetration panel;

(b) a first end section on a first side of the penetration panel for interconnecting said central section and said AC/DC converter; and

(c) a second end section on a second side of the penetration panel for interconnecting said central section and said battery pack.

15. The battery charger system of claim 14 wherein said central section comprises:

(a) a circular connector at one end thereof for connection to said first end section; and

(b) a D-shell connector at another end thereof routed into said aperture for connection to said second end section.

16. The battery charger system of claim 14 wherein said central section comprises:

(a) a D-shell connector at one end thereof for connection to said second end section; and

(b) a circular connector at another end thereof routed into said aperture for connection to said first end section.

17. The battery charger system of claim 14 further comprising ferrite clamps installed on both ends of said second end section.

18. A battery charger system for use with a battery-powered system, the battery charger system comprising:

(a) a power supply for supplying DC power; and

(b) a battery pack including a battery and a charging module, said charging module connectible to said power supply for receiving the DC power therefrom and capable of monitoring an operating mode of said battery-powered system when linked thereto such that when said battery pack is:

(I) disconnected from said battery-powered system, said charging module enables said power supply to charge said battery with the DC power therefrom; and

(II) connected to said battery-powered system, (A) upon detecting said battery-powered system in an idle mode of operation, said charger module routes the DC power from said power supply to both said battery for the charging thereof and said battery-powered system for operation thereof; and (B) upon detecting said battery-powered system in a non-idle mode of

operation, said charger module prevents said power supply from charging said battery and enables said battery to provide DC power to said battery-powered system.

19. The battery charger system of claim 18 wherein, when said power supply is disconnected from said battery pack, said charging module enables said battery to provide DC power to said battery-powered system whether said battery-powered system is operating in said non-idle mode or said idle mode.

20. The battery charger system of claim 18 wherein said battery-powered system is an injector system.

21. The battery charger system of claim 18 further including a DC power cord for interconnecting said power supply and said battery pack on opposite sides of a barrier, said DC power cord comprising:

(a) a central section for routing into an aperture of the barrier;

(b) a first end section on a first side of the barrier for interconnecting said central section and said power supply; and

(c) a second end section on a second side of the barrier for interconnecting said central section and said battery pack.

22. The battery charger system of claim 21 wherein said central section comprises:

(a) a circular connector at one end thereof for connection to said first end section; and

(b) a D-shell connector at another end thereof routed into said aperture for connection to said second end section.

23. The battery charger system of claim 21 wherein said central section comprises:

(a) a D-shell connector at one end thereof for connection to said second end section; and

(b) a circular connector at another end thereof routed into said aperture for connection to said first end section.

24. The battery charger system of claim 21 further comprising ferrite clamps installed on both ends of said second end section.

25. A charging module for a battery for use with an injection control unit of an injector system, the charging module comprising:

(a) an output selector stage for sensing a mode of operation of said injection control unit and for providing a turn-on signal when said injection control unit is operating in an idle mode and a turn-off signal when said injection control unit is operating in a non-idle mode;

(b) a charging stage connected to said output selector stage such that upon receiving (I) said turn-off signal, said charging stage prevents said battery from being charged by a power supply therefor and enables said battery to provide DC power to said injection control unit and (II) said turn-on signal, said charging stage enables DC power from said power supply to be conveyed to said injection control unit and assumes:

(A) a low current charging mode, when a voltage level of said battery is less than a preselected minimum level, wherein said charging stage charges said battery with a charging current therefor limited to a trickle level, and

(B) a multi-state charging mode, when said voltage level of said battery is said preselected minimum level or greater, wherein said charging stage operates according to:

(i) a bulk-charge state, when said voltage level of said battery is said preselected minimum level or greater yet below a set percentage of an overcharge level, wherein said charging stage charges said battery with said charging current at a peak level thereof,

(ii) an over-charge state, when said voltage level of said battery is equal to or exceeds said set percentage of said overcharge level, wherein said charging stage continues charging said battery until said charging current falls to a minimum threshold, and

(iii) a standby state, when said charging current falls below said minimum threshold, wherein said charging stage applies a constant voltage to said battery until said voltage level of said battery drops at least a specified percentage below a float level upon which said charging stage will commence operating according to said bulk-charge state; and

(c) an indicator stage for indicating when said power supply is capable of providing to the charging module sufficient power to efficiently charge said battery.

26. The charging module of claim 25 wherein said output selector stage includes:

(a) a current monitoring circuit for sensing current drawn by said injection control unit and for outputting an output voltage (I) less than a predetermined threshold when said current is less

than a predetermined level thereby indicating that said injection control unit is operating in said idle mode and (II) greater than said predetermined threshold when said current is greater than said predetermined level thereby indicating that said injection control unit is operating in said non-idle mode; and

(b) a comparator circuit for comparing said output voltage of said current monitoring circuit with a nominal reference voltage such that when said output voltage is (I) less than said predetermined threshold, said comparator circuit outputs said turn-on signal and (II) greater than said predetermined threshold, said comparator circuit outputs said turn-off signal.

27. The charging module of claim 26 wherein said current monitoring circuit includes:

(a) a current shunt monitor for monitoring said current drawn by said injection control unit and outputting an interim current proportional thereto; and

(b) an external load resistor for converting said interim current into said output voltage corresponding thereto

28. The charging module of claim 25 wherein said charging stage includes an activating transistor and a charging circuit such that:

(a) said activating transistor is connected to said output selector stage so that upon receiving (I) said turn-on signal, said activating transistor operably connects said power supply to said charging circuit and (II) said turn-off signal, said activating transistor operably disconnects said power supply from said charging circuit; and

(b) said charging circuit is responsive to (I) said turn-off signal by preventing said battery from being charged by said power supply and enabling said battery to provide DC power to said injection control unit and (II) said turn-on signal by being operable variously in said low

current charging mode and said multi-state charging mode depending on said voltage level of said battery.

29. The charging module of claim 28 wherein said charging circuit includes a Unitrode UC3906 battery charger controller chip.

30. The charging module of claim 28 wherein said activating transistor is a P-channel MOSFET.

31. The charging module of claim 25 wherein said indicator stage includes:

(a) a light-emitting diode having an anode connected to said power supply; and

(b) a comparator circuit having an output connected to a cathode of said light-emitting diode, said comparator circuit for comparing an output voltage of said power supply with a reference voltage such that when said output voltage is (I) greater than a preset upper level, said comparator circuit turns on said light-emitting diode and (II) less than a preset lower level, said comparator circuit turns off said light-emitting diode.

32. A charging module for a battery for use with a battery-powered system, the charging module comprising:

(a) an output selector stage for sensing current drawn by said battery-powered system and for providing a turn-on signal when said current is less than a predetermined level and a turn-off signal when said current is greater than said predetermined level; and

(b) a charging stage connected to said output selector stage such that upon receiving (I) said turn-off signal, said charging stage prevents said battery from being charged by a power supply

therefor and enables said battery to provide DC power to said battery-powered system and (II) said turn-on signal, said charging stage enables DC power from said power supply to be conveyed to said battery-powered system and assumes:

(A) a low current charging mode, when a voltage level of said battery is less than a preselected minimum level, wherein said charging stage charges said battery with a charging current therefor limited to a trickle level, and

(B) a multi-state charging mode, when said voltage level of said battery is said preselected minimum level or greater, wherein said charging stage operates according to:

(i) a bulk-charge state, when said voltage level of said battery is said preselected minimum level or greater yet below a set percentage of an overcharge level, wherein said charging stage charges said battery with said charging current at a peak level thereof,

(ii) an over-charge state, when said voltage level of said battery is equal to or exceeds said set percentage of said overcharge level, wherein said charging stage continues charging said battery until said charging current falls to a minimum threshold, and

(iii) a standby state, when said charging current falls below said minimum threshold, wherein said charging stage applies a constant voltage to said battery until said voltage level of said battery drops at least a specified percentage below a float level upon which said charging stage will commence operating according to said bulk-charge state.

33. The charging module of claim 32 further comprising an indicator stage for indicating when said power supply is capable of providing to the charging module sufficient power to efficiently charge said battery.